PRE-ATTACK POSTURE OF THE RED-TAILED HAWK

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Thorpe (1951:253–254), Meinertzhagen (1959:13) and others have suggested that prey animals may not only recognize predators as such but also be able to distinguish between times when the predators are ready to attack and those times when they are not. During experiments performed by Hamerstrom (1957), various song birds mobbed a tethered Red-tailed Hawk (*Buteo jamaicensis*) more often when it was hungry than when it was well-fed. Hamerstrom suggested that the song birds recognized differences in body and feather postures of the hawk. Several interesting biological questions arise from the implied possibility that a *perched* hawk shows evidence of readiness to attack. Although young raptors show evidence of hunger by food-begging while still being fed by their parents, it seems that any behavior that might warm prey of danger would be quite disadvantageous and should be selected against.

While many raptor attacks on prey occur from perched positions, most raptor-prey observations have dealt with flying raptors (e.g. Rudebeck, 1950) or with perched raptors that were being mobbed but not actually seeking prey themselves (e.g. Curio, 1963). The little information on pre-attack behavior of perched raptors is vague and often contradictory (cf Hamerstrom, 1957; Mavrogordato, 1960:5; Cade, 1960:221). In attempt to identify possible cues of a raptor's readiness to attack, I recorded the postures of captive and free-living Red-tailed Hawks, then offered them prey, and recorded their reactions.

The Red-tailed Hawk was chosen because: it is common and readily available for study; it is relatively easy to observe under both captive and field conditions; its general ecology, behavior, and distribution are well known (Bent, 1937; Fitch et al., 1946; and Craighead and Craighead, 1956): and it is a species in which potential prey are alleged to be able to distinguish "hunger" (Hamerstrom, 1957).

METHODS

Three Red-tailed Hawks were placed independently in a flight room with solid walls (Fig. 1) specially designed for detailed observations and analyses of responses to prey. "One-way" plastic windows prevented the hawk from seeing the investigator. A time-lapse 16 mm motion-picture camera (Bolex), with a 15 mm wide-angle lens, placed approximately one meter from the bird, took one picture every six seconds during day periods (artifically lighted) from 06:00–18:00. I induced the hawks to spend most of their time before the camera by placing the highest, thus most preferred, perch at

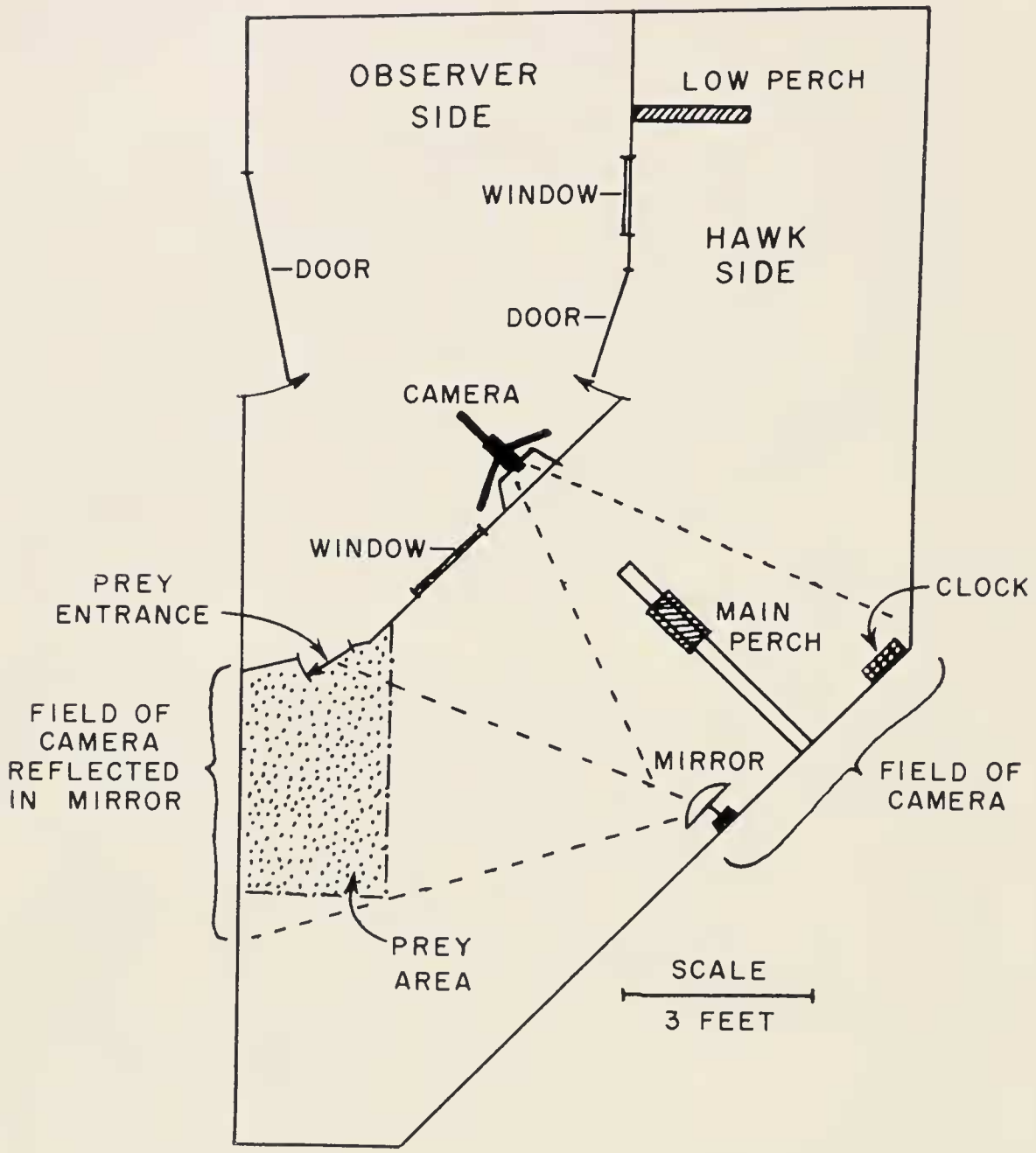

Fig. 1. Diagram of laboratory, as viewed from above.

that point. A parabolic mirror reflecting the part of the room where prey were presented and a clock were also included in the camera's field (Fig. 1).

To analyse the hawk's postures, single frames from the time-lapse film sequences were sampled by running the films through a single-frame analysing projector and stopping it randomly. From the projected picture several aspects of the birds' appearances, such as body posture, angle of tail from vertical, diameter of eye, etc., were either measured or categorized and recorded on prepared tally sheets.

Two of the Redtails were subadult birds trapped from the wild and placed into the room. The third Redtail was taken from its nest as a downy chick and raised in the observation room.

The formerly free-living individuals adjusted to the observation room quickly. Within hours they showed normal preening behavior, but both birds refused prey (live or dead) during the first four days.

Prey for all birds consisted of mice tossed through a small door onto the floor at one end of the room (Fig. 1). Care was taken that no cues of the forthcoming prey, such as noise from the observer, were available to the hawks.

I observed free-living hawks from roads in south-central Wisconsin from November 1966 to June 1967 and from September 1967 to November 1967. Bal-chatri raptor traps (Berger and Mueller, 1959), noose-covered cages containing live starlings or mice, were dropped onto the road near the perched birds then watched until either the hawk responded to the trap or 30 minutes elapsed. Various pertinent environmental conditions and the hawk's appearance and behavior were recorded on prepared tally sheets.

RESULTS

Contrary to earlier suggestions, neither captive nor free-living hawks displayed obvious cues of readiness to attack when unaware of a prey stimulus.

All three captive birds were inactive most of the time. They perched vertically with feathers fluffed and one foot often drawn up into the plumage. Aside from frequent head movement and occasionally preening. inactive birds showed little movement; however, after one-half hour to three hours of inactivity, the birds became restless and active for periods of a few minutes to two or more hours. The Craigheads (1956:30–34) have described similar alternating activity periods in free-ranging Redtails. During active periods the captive birds flew between perches. Between flights they characteristically assumed a forward posture with feathers compressed and moved their heads considerably. The first active period usually began about mid-morning following a long period of inactivity and preening. The birds showed much day to day variability in the frequency and extent of these active periods.

Since hawks obviously appeared differently when relaxed than when restless and active, pictures from time-lapse sequences were identified not only as to whether or not the hawk took subsequent prey but also whether the picture occurred during an active or inactive period. Thus birds that subsequently took prey could be compared with those that did not. not only on an overall basis but within periods of activity or inactivity. It appeared that the amount or frequency of activity was independent of amount or recency of previous feeding.

In three of four of the hawks' postures that were categorized (Table 1). no significant differences (by Chi-square) occurred between those which attacked subsequent prey and those which did not. whether the hawk was active or inactive. In the fourth aspect, whether or not the eyes were wide

TABLE 1

POSTURES OF CAPTIVE HAWKS AND REACTION TO SUBSEQUENT PREY

Hawk Posture		Condition of Hawk and Reaction to Subsequent Prey							
		Active, attacked	Active, did not attack	Inactive, attacked	Inactive, did not attack	Totals			
						Active	Inactive	Attacked	Did not attack
Feet on perch:	1	0	0	20	28	0	48	20	28
	2	39	38	7	16	77	23	46	54
Body posture:	upright	0	0	26	43	0	69	26	43
	forward	39	38	1	1	77	2	40	39
Plumage:	compressed	38	35	5	10	73	15	43	45
	fluffed	1	3	22	34	4	56	23	37
Eye:	wide open	31	26	15	7	57	22	46	33
	partly closed	1	4	11	28	5	39	12	32
	(not discernable in picture)	(7)	(8)	(1)	(9)	(15)	(10)	(8)	(17)
Sample size*	(no. of photo)	39	38	27	44	77	71	66	82

* Photos selected randomly from all available for each condition of hawk but sample sizes for each condition were chosen to be approximately equal (movement, etc. caused loss of some pictures hence prevented equal replication).

open, a significant difference ($p < 0.05$) occurred between inactive birds: those which attacked subsequent prey had their eyes wide open more often (discussed below).

Several aspects of the birds appearances (e.g. width of eye, extent feathers raised on various parts of body) were additionally measured from photographs and multiple-comparison statistics applied. Those results, however, simply confirmed the above data.

Free-living Redtails similarly responded to prey independently of their behavior prior to seeing the prey. Birds in the upright posture before testing responded less often than birds in the forward posture (Table 2); however, this difference is not statistically significant. Furthermore, the two Redtails that responded fastest and most persistently, despite disturbances which

Table 2

Postures of wild Red-tailed Hawks prior to Prey Presentation and Subsequent Responses towards the Prey

	Response		
Posture of Bird	Clear *	Slight or none	Total
Upright	6	17	23
Forward	9	10	19
Total	15	27	42

$\chi^2 = 1.23$, $p > 0.20$

* Hawk flew to within ten feet of natural or artificially presented prey.

usually frighten Redtails, were birds initially recorded as upright and with very fluffed plumages.

In contrast to hawks in the absence of prey, hawks that were *aware* of prey items generally left little doubt to future action, since the observer knew the location of the prey. Those birds which attacked compressed their plumage upon sensing the prey, oriented their body toward the prey, stood forward on both feet, then left the perch to attack, often after first defecating. Those which did not attack usually simply remained as they were before sensing the prey. The change to the alert posture in a relaxed bird that would attack was very noticeable. Such change can be seen, for example, in changes of tail angle (from vertical, as representing body angle) from consecutive time-lapse photographs (Fig. 2). Due to the birds' being already in a forward standing position during active periods, the reaction toward prey was less noticeable (and not detectable in tail angles, Fig. 2). Knowing that the hawk was preparing to attack *prey* involved knowing the *location* of the prey and recognizing the hawk's orientation towards it. Aside from the direction of orientation, however, the simple pre-flight posture previous to attack was identical to that shown previous to flight not involving attack.

The *time* required for a bird to leave its perch, in cases of attack, appeared to depend largely on the birds familiarity with the situation. In extreme cases in the laboratory, after the birds had become conditioned to the surroundings and procedures, they would leave the perch in less than 0.5 second after seeing the prey. This fast reaction occurred even from relaxed upright postures suggesting that the forward posture may not give the bird and advantage in reducing attack-time. It may merely be a posture assumed while the bird determines whether or not to attack.

Free-living Redtails responded to prey essentially as captive birds did. Birds that did not attack usually remained as they were before the trap was

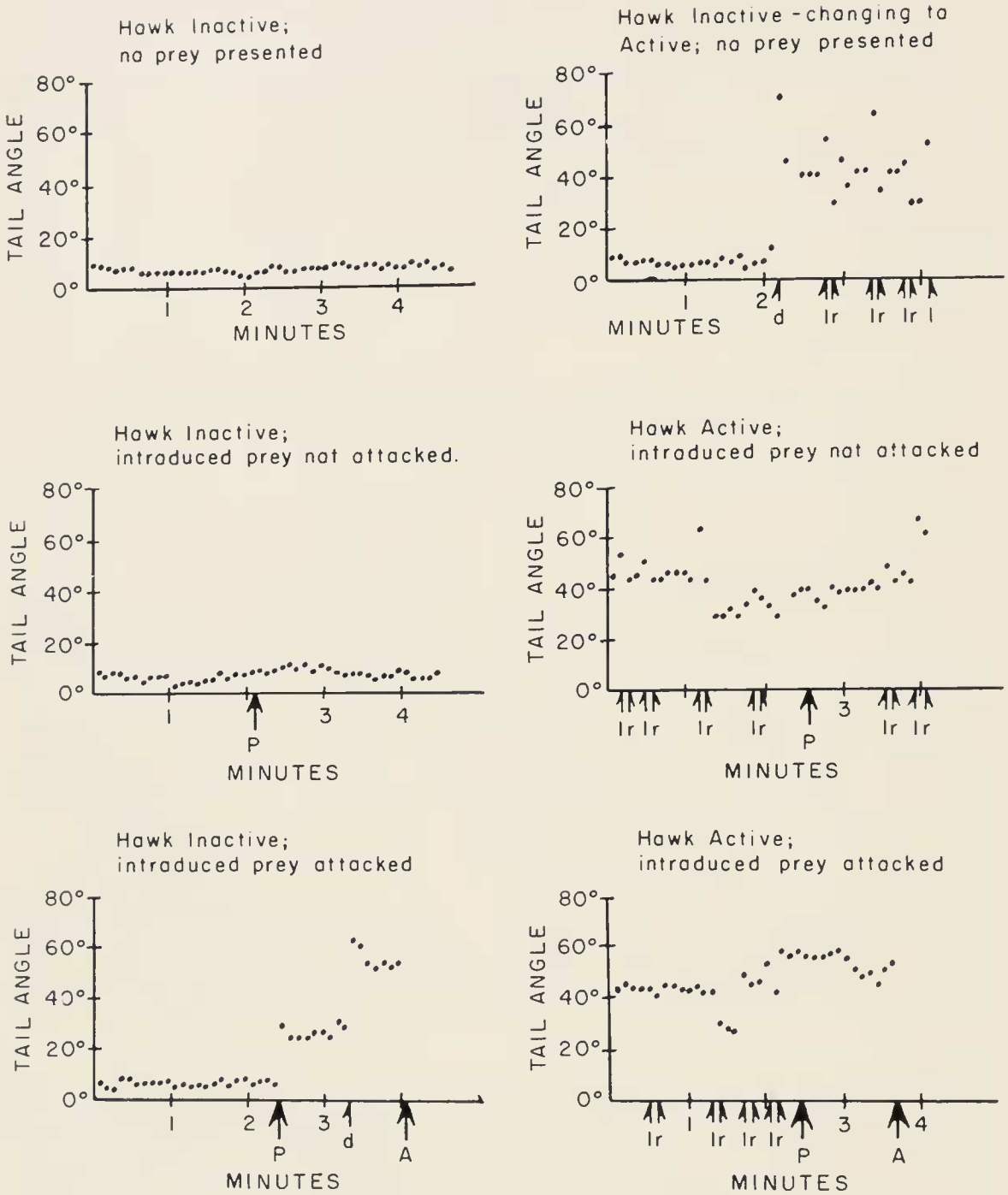

FIG. 2. Changes in angle of hawk tails, from time-lapse photograph sequences. P = prey presented to hawk, A = hawk left perch to attack prey, d = hawk defecated, l = hawk left main perch to fly (not attack), r = hawk returned to main perch.

presented and only glanced occasionally at it. In some instances the hawk briefly stood forward then gradually resumed a relaxed apearance or left the vicinity. Hawks that attacked usually stood forward and watched the trap intently for periods ranging from about ten seconds to over ten minutes, then left their perches to attack. As in the case of the captive birds, however,

the pre-flight postures were not unique for prey capture. Hawks were seen to fly on several occasions under circumstances not involving food, such as avoiding a disturbance or simply changing perches. Aside from the direction of orientation, such flights were preceded by postures that were identical to those involving attack, i.e. forward body posture on both feet, compressed plumage, and attention focused at a distant point.

DISCUSSION AND CONCLUSIONS

The various postures and aspects of the hawks' appearances that I analysed, specifically included those listed by Hamerstrom (1957) as being potential cues to a hawk's readiness to hunt. Yet no differences were found between birds that would attack and those which would not for any of the characteristics except the diameter of the eye: inactive hawks held their eyes wide open more often when likely to attack. A wide open eye could possibly serve as a cue of readiness to attack but such by itself would not seem to be a very obvious or useful cue at a distance.

When a hawk was aware of a specific prey item and prior to leaving its perch to attack, it showed clear indications, as described in the results, that it was about to fly. Such flight intention movements were also seen, however, in almost all situations involving flight, i.e. simply changing perches, moving from disturbances, and in extended periods of flight. Knowing that a bird was preparing to pursue prey would require knowledge of the location of prey. If a particular potential prey item is *the* object of a hawk's attention, and was aware of the hawk, it might be able to sense the hawks intent to attack and react accordingly. But otherwise seeing a hawk preparing to fly would not indicate whether or not it would be ready to attack prey.

Not only were subtle indications of readiness to hunt absent but even the most obvious appearances yielded no clues. Hamerstrom (1957) stated that, "A healthy hawk standing on one foot with the other foot tucked up under his feathers is not inclined to hunt." I found numerous exceptions to this in free-living birds, and captive Redtails regularly perched on one foot with relaxed plumage even though ready to attack if the opportunity occurred. Apparently the observations by Cade (1960:221) and Mavrogordato (1960:5) of raptors taking prey from an initially relaxed posture were not exceptions from normal behavior.

Indication of hunger by food-begging behavior is common in young raptors, between mates, and is commonly shown towards humans by hand-reared raptors trained in falconry. Similar behavior is also shown occasionally by other captive raptors, particularly Accipters (cf "yarak," illustrated in Beebe and Webster, 1964). Cade (1962) has shown that Northern Shrikes

(*Lanius excubitor*) on occasion employ behavior resembling food-begging during interactions with prey, resulting in the flushing of the prey. Such behavior, or some subtle trace of it, could provide prey with cues of readiness to attack. However, I observed no detectable evidence of food-begging by Redtails during encounters with prey at any time during the course of my experiments. Food-begging in raptors is probably restricted to interactions between members of a species or involving a human trainer.

Although I have found little in the appearance of a hawk to indicate readiness to attack, one might hypothesize that some prey have ability to detect something about the raptor that I cannot. Recent work on other aspects of recognition of raptors by prey (e.g. flying raptors: von Schleidt, 1961; perched raptors: Hinde, 1954) indicate that the raptor is apparently regarded by potential prey, at least initially, not as a predator as such (except perhaps with owls) but as an unfamiliar or suddenly appearing stimulus to be avoided or mobbed. If no attack results with the repeated presence of the raptor, the prey animal become habituated to its presence and the avoidance response subsides. Habituation seems to me to be possible even when the raptor is hungry but does not attack because the prey is not seen, is not of a type familiar to the raptor, or is of a species which the raptor has been unsuccessful in capturing and therefore no longer attempts to capture. If the raptor *does* attempt an attack but fails and the potential prey individual survives, the avoidance response may become heightened in the prey (see Berger et al. 1963:781).

In view of my evidence that Red-tailed Hawks display no overt unique indication of readiness to attack and since concepts of habituation afford plausable alternative explanations, I feel that a potential prey's lack of escape behavior in the presence of a raptor is due either to the prey not being aware of the raptor or the prey's regarding the raptor as a familiar and harmless object. Those potential prey items that show escape behavior in the presence of a raptor either regard it as an unfamiliar object or recognize that an actual attack has commenced.

SUMMARY

Perched captive and free-living Red-tailed Hawks were categorized according to posture and then offered prey to test for differences between those that would and those that would not attack. No differences were found in hawks before they sensed an actual prey item. After sensing prey hawks that were likely to attack could be identified by their alert reaction toward the prey but such behavior was identical, except for orientation, to pre-flight behavior when food was not involved. It is doubtful whether prey can distinguish between hungry and satiated hawks, except after the hawk has begun an actual attack. Habituation of prey to the raptor provides an alternative explanation for most prey behavior that has been observed.

ACKNOWLEDGMENTS

Several persons, particularly Joyce Grier, R. Miller, and J. Weaver, aided with the field aspects of this project. I am most indebted to Drs. J. T. Emlen and Frances Hamerstrom who offered many helpful discussions and criticisms during the project and subsequent analysis and writing. D. D. Berger, Dr. H. C. Mueller, F. Renn, C. R. Sindelar, J. Weaver and others also offered many valuable discussions. Joyce Grier assisted greatly in the collecting and handling of the laboratory data.

Facilities and equipment used in the laboratory observations and the vehicle used in field work were provided by the Zoology Department of the University of Wisconsin at Madison, Wisconsin. I was supported during the course of the project by a National Science Foundation Graduate Fellowship.

LITERATURE CITED

Beebe, F. L. and H. M. Webster. 1964. North American falconry and hunting hawks. World Press, Inc., Denver.

Bent, A. C. 1937. Life histories of North American birds of prey. U. S. Natl. Mus. Bull., 167.

Berger, D. D. and H. C. Mueller. 1959. The Bal-Chatri, a trap for the birds of prey. Bird-Banding, 30:18–26.

Berger, D. D., F. Hamerstrom, and F. N. Hamerstrom, Jr. 1963. The effect of raptors on Prairie Chickens on booming ground. J. Wildl. Mgt. 27:778–791.

Cade, T. J. 1960. Ecology of the Peregrine and Gyrfalcon populations in Alaska. Univ. of California Publ. Zool., 63:151–290.

Cade, T. J. 1962. Wing movements, hunting, and displays of the Northern Shrike. Wilson Bull., 74:386–408.

Craighead, J. J. and F. C. Craighead. 1956. Hawks, owls, and wildlife. Stackpole Co., Harrisburg, Pennsylvania.

Curio, E. 1963. Probleme des Feinderkennes bei Vogeln. Proc. 13th Internatl. Orinthol. Congr., 1:206–239.

Fitch, H. S., F. Swenson, and D. F. Tillotson. 1946. Behavior and food habits of the Red-tailed Hawk. Condor, 48:205–237.

Hamerstrom, F. 1957. The influence of a hawk's appetite on mobbing. Condor, 59: 192–194.

Hinde, R. A. 1954. Factors governing and changes in strength of a partially inborn response, as shown by the mobbing behavior of the Chaffinch (*Fringilla coelebs*), Proc. Royal Soc. B., 142:306–358.

Mavrogordato, J. G. 1960. A hawk for the bush. Neill and Co., Ltd., Edinburgh.

Meinertzhagen, R. 1959. Pirates and predators. Oliver and Boyd, Edinburgh.

Rudebeck, G. 1950. The choice of prey and modes of hunting of predatory birds with special reference to their selective effect. Oikos, 2:65–88; 3:200–231.

Schleidt, W. M. von. 1961. Reaktionen von Truthuhnern auf fliegende Raubvogel und Versusche zur Analyse ihrer AAAM"S. Z. Tierpsych. 18:534–560.

Thorpe, W. H. 1951. The learning abilities of birds. Ibis, 93:252–296.

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